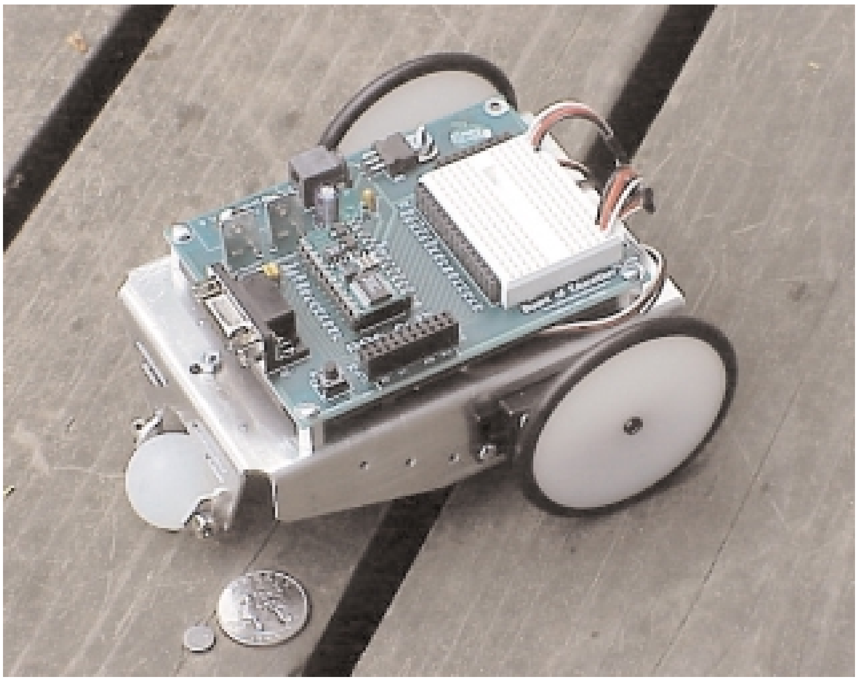
BASIC Stamp programming course (1)

Part 1: Introduction and BoE hardware

This is the first of a series of articles discussing the assembly of a simple robot, called BoE-Bot, we'll use to learn introductory programming with the BASIC Stamp. The BoE portion is the BOARD OF EDUCATION, and the Bot refers to robot chassis. The project is flexible, and could also be a rolling breadboard. Provided you've got a Stamp-based servo driven platform, following the lessons will be easy.

By Chuck Schoeffler, Ph. D. and Ken Gracey



Photograph showing author's version of BoE. Readers should note that this differs slightly from the BoE described in this article.

Robotic projects are an ideal way to learn how to interface a microcontroller to other electronic components. It's effective for students of all ages to see and hear outputs in addition to measuring them with a multimeter or oscilloscope. Teachers often say that it requires light, sound, and movement to capture a student's interest. This first column consists of assembling a BASIC Stamp II Board of Education-based robotic platform named the BoE-Bot. Once you've built this platform we'll use it to teach basic microcontroller skills. The article installments are planned as follows (subject to change):

- ➡ *Introduction and BoE construction*, September 1999 — The part you are reading right now. The BoE printed circuit board was designed by *Elektor Electronics* from an example supplied by the authors. Brief introduction to the BASIC Stamp II.
- ➡ *Building the BoE-Bot*, October 1999 – Construction process and drawings for building the BoE-Bot.
- ➡ *BASIC Programming*, November

1999 — Program the BoE-Bot to follow a pre-entered path using subroutines, IF..THEN, and EEPROM storage. These are the basic programming fundamentals.

- *Sensors*, December 1999 — Use a photoresistor to sense and follow light. Use a wire as a switch closure for the bumper and generate sound with a piezospeaker.
- *Infrared Control*, January 2000 – Add an infrared LED for proximity sensing and external control by hand-held remote.
- *Advanced BoE-Bot Projects*, February 2000 — Schematic and source code ideas for advanced BoE-Bot projects including sonar and communication.

The BoE part of BoE-Bot is the Board of Education, a platform to hold your BS2-IC microcontroller system and prototype your sensor projects. The original board was designed by Parallax in coordination with educational customers to teach microcontroller interfacing. It is designed for use with the Parallax Stamps in Class curriculum, available for free download in Adobe's PDF format. Therefore, the use of a BoE on a robot chassis has more purpose than this single use as a robot project area.

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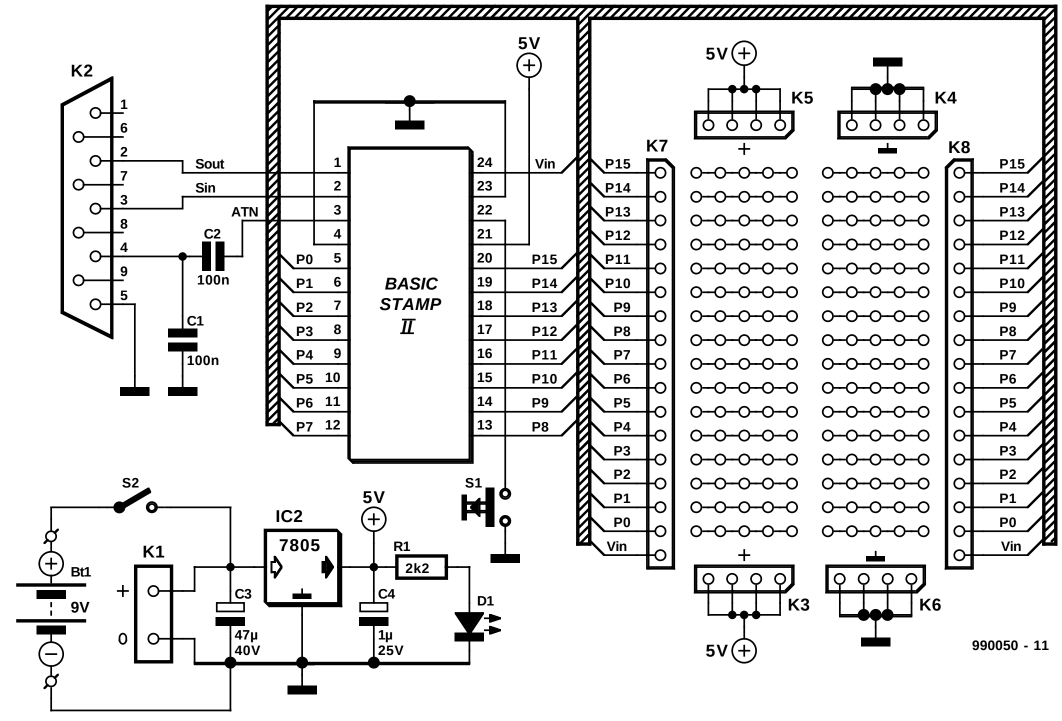

Figure 1. Circuit diagram of the Board of Education (BoE).

The robot chassis is the Bot. Measurements are provided so you can build your own chassis on computer numerical control (CNC) metal machinery, or cut one from plastic or even wood. With the publication of part 2 of this course, the mechanical parts will hopefully also be available ready-made.

BASIC STAMP MICROCONTROLLER

The BASIC Stamp is an inexpensive (less than $50USD) microcontroller with a built-in BASIC interpreter. The majority of microcontrollers require some special programming hardware. The BoE-Bot was designed around the most popular BASIC Stamp version — the BS2-IC. Here are some of the features of a BASIC Stamp:

- Small size, like a postage stamp.
- BASIC interpreter firmware is built into the PIC16C57 microcontroller.
- BASIC program storage in electrically erasable EEPROM. When power is applied the program executes. BASIC Stamps can be programmed at any time by temporarily connecting them to a PC running a simple host program. Type in a new program, press a key, and the program is downloaded to the BASIC Stamp.
- I/O pins that can communicate with digital devices sense switches, and even directly drive small loads like LEDs.

At this point in the course, the Stamp module will be treated as a black box. If you haven't already seen the BASIC Stamp II, you can download the manual, datasheets, and DOS/Windows editors from the Parallax web site. The UK distributor for the Parallax Stamp is Milford Instruments, telephone (01977) 683665, *www.milinst.demon.co.uk*

BUILDING THE BOARD OF EDUCATION

The Board of Education (BoE) consists of a BASIC Stamp II module, a simple power supply, a prototyping area and some simple peripherals like a reset switch, an LED and a serial interface connector. The circuit diagram is shown in **Figure 1**.

Position IC1 is a 28-pin DIL socket in which the BASIC Stamp II module is plugged. The module communicates with your PC's serial port via a 9-way sub-D socket, K2. Note that a rudimentary form of handshaking is employed by capacitive coupling of the DTR (data terminal ready) signal on pin 4 of K2 to the ATN input line of the Stamp module.

The BASIC Stamp module can be reset by pressing push-button S1. The switch will be used whenever a program is to be downloaded into the Stamp.

All of the Stamp's I/O lines plus its V_{in} line (PWR, 9-15 V, see Stamp datasheets)) are 'bused' onto SIL sockets arranged adjacent to a prototyping area (breadboard) for easy connection to your own experimental circuits.

A simple on-board power supply

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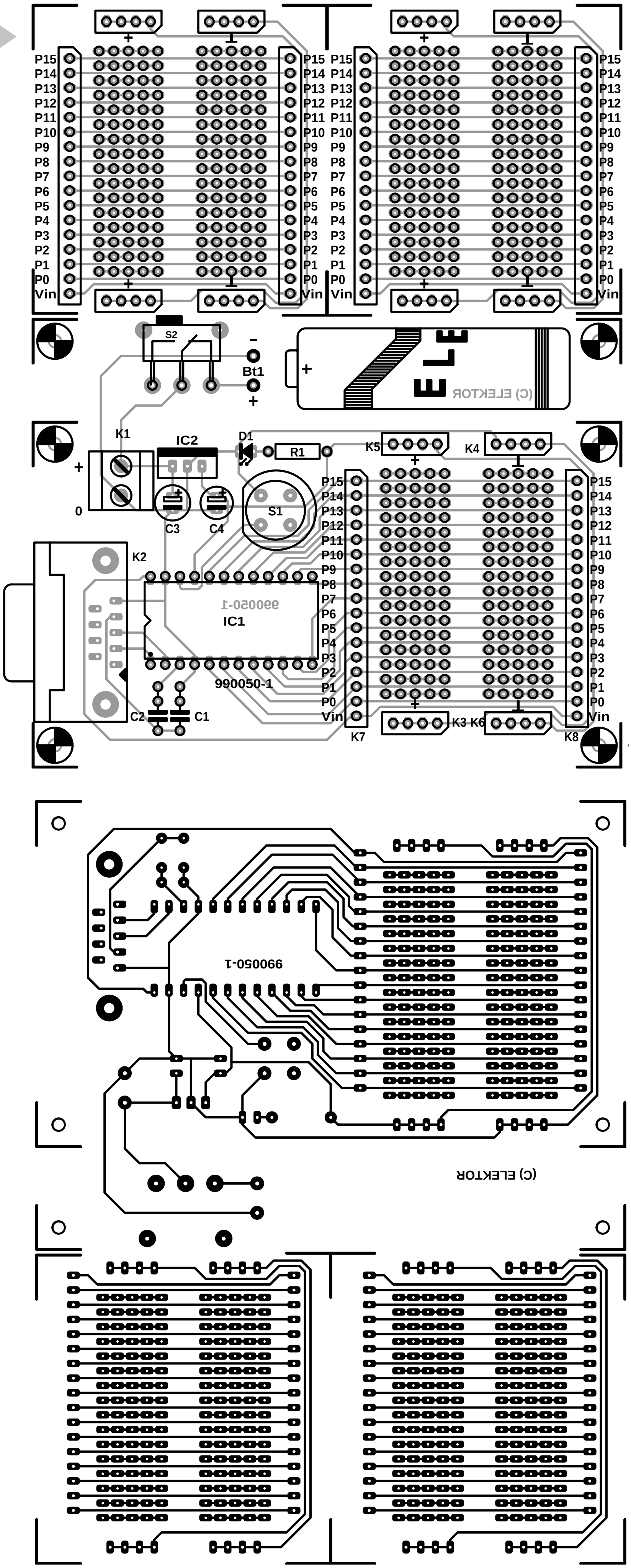

Figure 2. Artwork for the single-sided circuit board (available ready-made).

COMPONENTS LIST

Resistors:
R1 = 2kΩ2

Capacitors:
C1,C2 = 100nF
C3 = 47µF 40V radial
C4 = 1µF 25V radial

Semiconductors:
D1 = LED, red
IC2 = 7805

Miscellaneous:
Bt1 = 9V PP3 (6F22) battery with clip-on leads
IC1 = BASIC Stamp-2 module (available from Parallax distributors)
K1 = 2-way terminal block, raster 7.5mm
K2 = 9-way sub-D socket (female), PCB mount, angled pins
K3-K6 = 4-way SIL socket, turned pins
K7,K8 = 17-way SIL socket, turned pins
S1 = pushbutton, 1 make contact, PCB mount, type D6-R-RD (ITC)
S2 = slide switch, PCB mount
1 off 28-pin IC socket
2 off M3 nut and bolt for securing K2
PCB, order code **990050-1** (see Readers Services page)

allows the BoE to be powered either by a battery or a mains adaptor rated at 9 VDC/300 mA. A more powerful adaptor may be required depending on what you intend to connect to the SIL socket, or build in the prototyping area. Note that IC2 may then require a heatsink.

Warning. The mains adaptor must not be connected when the on-board battery is powering the circuit (switch S2 closed).

LED D1 lights when the 5-V supply voltage is present. The 5-V regulated (and decoupled) supply voltage is also made available to the experimental circuits via SIL sockets, this time K3 and K5. Two more SIL sockets, K4 and K6, are available for ground connections.

CONSTRUCTION

The printed circuit board designed for the BoE is shown in **Figure 2**. It is single-sided and available through the *Elektor Electronics* Readers Services as well as kit suppliers like C-I Electronics and Viewcom Electronics.

Stuffing the board should not present undue difficulty easy as the PCB

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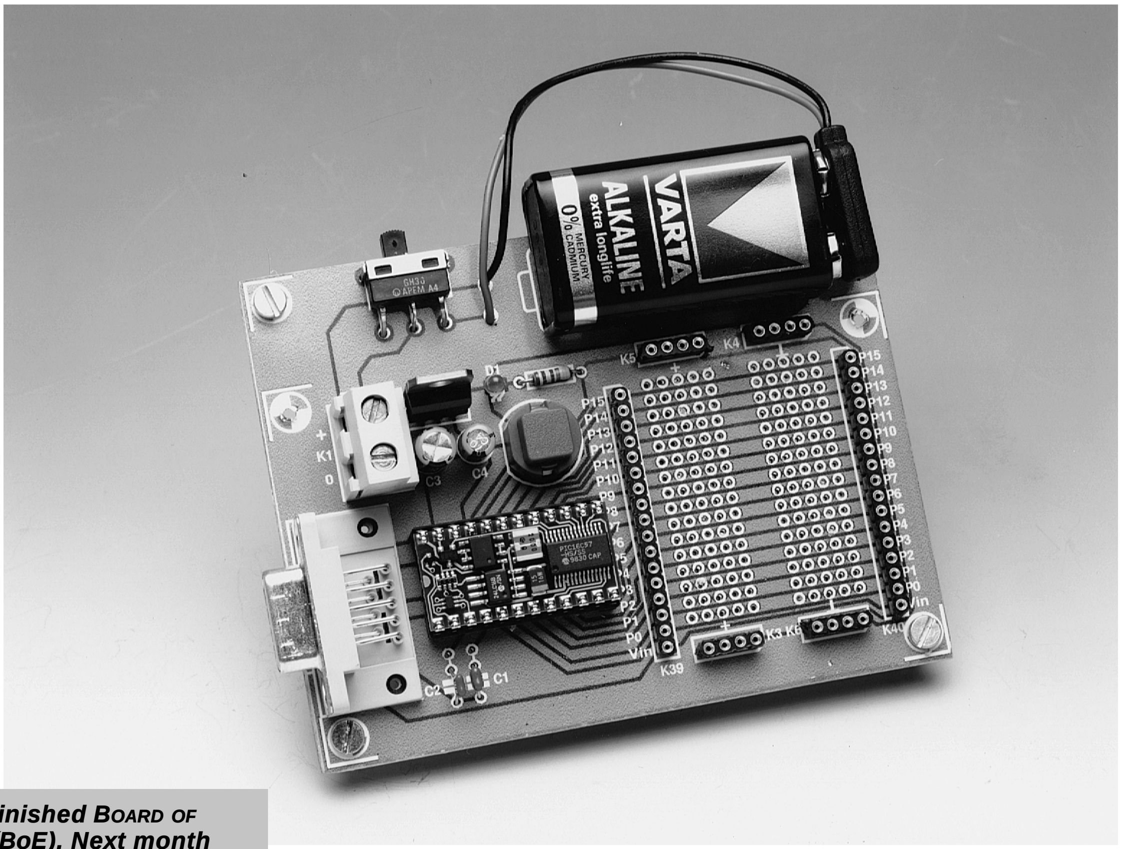

Figure 3. Finished Board of Education (BoE). Next month we'll be installing the board on a home-made robot vehicle.

layout is generous and no special components are involved. Be sure to use a socket, that is, a **female connector**, in position K2. Capacitors C3 and C4, regulator IC1 and (yes) the socket in position IC1 are all **polarised components** and have to be mounted the right way around on the board. When in doubt about the orientation, study the circuit diagram and the component overlay. The BASIC Stamp module should not be installed into socket IC1 before you've finished all soldering work on the BoE.

The finished BoE (**Figure 3**) brings the BS2-IC I/O pins available adjacent to a breadboard. Only minimal wire stripping and cutting tools will be required to customize the BoE-Bot for future experimentation. The two identical prototyping areas may be cut off for experiments. If you fit suitable SIL pinheaders at the solder side of these sub-boards, they may be inserted into the sockets on the main BoE. A finished BoE will feature the following:

- easy plug-on connection of prototype circuits to be controlled by the BASIC Stamp module;
- DB9 connector for BS2-IC programming and serial communication during run-time;
- BS2-IC's P0-P15 I/O pins, V_{dd} (+5 V) and V_{ss} (GND) connections brought adjacent to 4 cm x 3 cm breadboard area;
- traces on top of the board show connections between BS2-IC port lines and breadboard connections;
- battery section may be cut off if object to be controlled has its own power supply (min. 9 VDC, connect to K1);
- two extra breadboards.

WANT A HEADSTART?

If you are interested in learning microcontrollers without the robot part and just the BoE, download the free curriculum available from the Parallax educational web site *http://www.stampsinclass.com*

The design concept of using BASIC Stamp on a robotic platform as an educational tool comes from Chuck Schoeffler, University of Idaho. Dr. Schoeffler's first approach was a very inexpensive configuration using the BASIC Stamp Rev. D., and this design could be considered if you need a cost-effective alternative. The BASIC Stamp Rev. D. has a built-in through-hole prototype area for projects, and may be mounted it's own unique robot chassis. This approach can be very effective for schools.

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Next month:

BoE-Bot mechanical assembly and calibration.

Internet

http://www.parallaxinc.com – BASIC Stamp Manual Version 1.9, BASIC Stamp DOS and Windows Editor, program examples. International distribution sources.

*http://www.stampsinclass.com —BoE documentation, Robotics curriculum, BoE-Bot *.dxf*

*and *.dwg drawing formats, discussion group for educational uses of BASIC Stamp.*

chucks@turbonet.com — creator of the BoE-Bot and author of this series. Technical assistance.

kgracey@parallaxinc.com — co-author of this article. Technical assistance and questions about the educational program.

http://www.milinst.demon.co.uk — UK distributor of Parallax BASIC Stamp.